planning, rocker and long tom methods of washing gold to ground sluicing, drifting, and full scale hydraulic mining of alluvial terraces and old stream beds. The deep gravel deposits underneath the larger rivers such as the Klamath were also mined by constructing wing dams to divert the river away from the part that was to be mined. By 1862, the easier surface placer gold had been mined out and the boom time for Happy Camp Mining District had ended. Mine areas on higher ground above the rivers were surveyed and patented in the 1870's and 1880's. These included the Classic Hill, Blue Bar Placer, and the Howard Placer. Other lands along Indian Creek were homesteaded, and miners and other people brought in to the area by mining permanently settled (Toleman, 1966; Stumpf, 1979).

As placer and large scale hydraulic mining declined, lode mining and exploration for copper, gold, and silver became the dominant mining activity in the area by 1920. This was spurred on by the need for copper during World War I. The largest producing lode mine in the area and in Siskiyou county during this century was the Gray Eagle mine located up Luther Gulch. Exploration has occurred at this mine from 1895 to today, and production of copper, gold and silver has occurred during two periods, from 1841-1945 and from 1982 to 1987 (Toleman, 1966; Wright 1966).

Exploration of manganese and chromite deposits in the area occurred during the 1940's during WWII. Little is known of the extent of chromite mining other than a small amount was mined from the Herbert Cook Mine and other unnamed prospects. Manganese deposits and mineral prospects in the watershed include the Davis, Huey, Kelly Lake, and Wykoff Prospects, and the Rhodonite Mine. Of these, the Wykoff Prospect and Rhodonite Mine were the most developed claims. The Wykoff Prosepect is located on the Bolan Mountain Road, and includes at least one developed adit and a waste dump. No production is noted. The Rhodonite Mine includes a short adit, an open cut, and an ore stockpile. The mineral rhodonite is a pink to reddish brown mineral and is the primary ore mineral of manganese in this area. Though about 5 tons of rhodonite ore has been mined it is not known whether the ore was removed. The mine has also been prospected for gem-quality rhodonite (Trask, 1950).

The Indian Creek area is well known as a jade prospecting locality. The predominant mineral form of jade found is nephrite and vesuvianite. Nephrite (an amphibole of the tremolite-actinolite mineral series) ranges from black, dark green to white in color. Vesuvianite (also known as the mineral californite or idocrase) is commonly grass green in color speckled with white. The jade localities include the Chan Jade, and the King Jade Quartz mines on the South Fork Indian Creek and two prospects: the Cole Creek Prospect, and the Twin Valley Creek. Of these, the Chan is the most well known having been claimed by a Chinese miner in the early part of this century. As the legend goes, the miner was killed during a party celebrating his glorious jade finds there. It is said that Chan s ghost still comes back to the mine and the sound of fiddle playing and merrymaking can be heard throughout the river canyon there (Pashin, 1995).

Gray Eagle Mine

The Gray Eagle Mine has a long history as the largest copper, gold and silver mines in the county. The Gray Eagle mine is located about 2 miles up Luther Gulch. The first mining claims were filed in 1895 by W. I. Brown (Judge Brown) of Happy Camp. The five claims referred to as the Dewey Group were explored for gold by placer and underground methods from 1898-1904. From 1908-1914, additional mining claims were filed by F. H.Dakin. Dakin drove eight adits and discovered a large massive sulfide copper-bearing ore body.

By the end of WWI, though the ore body had been outlined, there was little interest to mine it due to the low price of copper. It was said that a body of more than one million tons of copper ore was blocked out, and there were more than 13,000 feet of underground workings. During the time period 1918 to 1942, the Gray Eagle Mining Company performed further exploratory and development work consisting of driving a haulage tunnel into the ore body and driving drifts and raises into the ore body (Wright, 1966; Siskon Corporation, 1990; U.S. EPA 1996).

The first period of production at the mine occurred in December of 1941 during WWII. At this time, the Grey Eagle Copper Company was a subsidiary of the Newmont Mining Company. The Grey Eagle mine property consisted of 16 patented claims and 16 unpatented claims. The gold order, which suspended gold mining during the war, forced Newmont to close its Empire Star Mine and Mother Lode Mine and begin copper production at Gray Eagle.

Mill facilities were constructed consisting of a roads up Luther Gulch, installation of electric power lines, construction of mine mill, camp and office buildings. Adits were widened to accomodate rail cars, electric cables and water lines. The entire mine operation was underground, developed by the room and pillar system, with minimal timbering. The mill was located in close proximity to the main adit portal. The ore was crushed by a jaw crusher and then by a cone crusher, and final grinding was done by two ball mills. The ground ore was further separated in a series of flotation cells. Cyanide, as well as other floatation agents were used to concentrate gold, silver and copper. The mill production rate was about 500 tons per day.

The ore concentrates were conveyed by a 3.5 mile long aerial tramway over Thompson Ridge and down to a terminal at Thompson Creek, where trucks hauled the concentrate to Yreka. The concentrates were shipped by rail to the smelter in Tacoma, Washington. Process tailings were conveyed by a flume to the mill tailings disposal area along Indian Creek just downstream from the mouth of Luther Gulch. The fine-grained, red mill tailings are still present today. Other mine waste from the tunnel workings was deposited in South Fork of Luther Gulch. The mine was operated on two 8-hour shifts. Miners worked on a contract price per ton or cubic foot basis, and contracts were for a 2-week period. In October 1944, they were earning an average of $12.06 per day (O'Brien, 1947). Literature sources and Bureau of Mines records indicate that 465,000 tons of ore was milled at an average grade of 3.17% Copper and 0.027 Gold per ton.

The mine was closed in July of 1945 and the claims and other lands were sold to Lester and Bertha Flanigan. In 1959 the Flanigans filed a quit claim deed in favor is Siskon Corporation for all mining claims and property associated with the Gray Eagle Mine (Wright, 1966, U.S. EPA, 1996). Siskon Corporation entered into various option agreements with other mining companies. One of these was with Standard Slag Company in 1967. Standard Slag retained some ownership interest in the mine through 1976 at which time it executed an option agreement with Noranda Mining Company. By 1977, Noranda Mining drilled over 14,000 feet to confirm the presence of a gold zone in the upper part of the ore body (U.S. EPA, 1996).

By October 1982, Noranda had put the mine back into production as a gold mine, and changed the mine's name to the Grey Eagle Mine. The ore was mined by open pit methods. Ore processing consisted of a grinding circuit, cyanide leaching, carbon adsorption, electrowinning, and bullion smelting. A tailings dam was constructed to contain water by-products from ore processing, and to store and treat process water from milling. Process tailings were deposited within the tailings dam. Mine waste rock, overburden and other rock was also used to build the dam. Excess water in the tailings impoundment was withdrawn, treated and discharged into shallow ponds at the land application site above Baker Gulch. Water from the headwaters of the South Fork of Luther Gulch was channeled into a diversion structure along the north side of the tailings dam and flowed into the South Fork of Luther Gulch. The mine closed in 1987. Over the 5-year period, 180,000 ounces of gold was produced from more than one million tons of ore processed at a grade of 0.21 oz. gold/ton.

Noranda Grey Eagle terminated its lease from the Standard Slag Company in 1987. In 1988, Siskon Corporation which owned the mine properties, was purchased by Centurion Gold Inc. The next year, Siskon Corporation conducted exploration work and undertook a mining feasbility study to evalute the copper, gold and silver potential of two large existing ore bodies on the claims (U.S. EPA, 1996; Siskon Corporation, 1990). No further exploration or development work at the mine has occurred since 1990. A complex series of mergers and corporate restructuring of Siskon Corporation occurred over the period of 1988-1991. Siskon Gold Corporation was the surviving corporation and presently owns many of the mining properties associated with the Grey Eagle Mine.

Environmental Problems Associated with the Grey Eagle Mine

Two significant environmental pollution problems are associated with mining operations at the Grey Eagle Mine. The first is acid drainage from: the old mine adits and underground workings covered by the tailings dam; and acid drainage associated with the mill tailings deposited on the floodplain of Indian Creek (the area known as the mill pond). The second problem was seepage of reactive cyanide from the tailings impoundment.

Uncontrolled release of acid mine drainage is considered to be the most serious environmental impact mining can have on the environment. Acid mine drainage from metal mines can contain dissolved heavy metals in toxic concentrations. Acid mine drainage is caused by the natural oxidation of sulfide minerals contained in ore, waste rock or process tailings when exposed to air and water. The oxidation reactions that start acid drainage are often accelerated and perpetuated by biological activity. The two most common sulfide minerals which oxidize and form acid are the iron sulfide minerals pyrite and marcasite. Not all mining operations that expose sulfide-bearing rock will result in acid drainage. It will not occur if the sulfide minerals are nonreactive or if the rock contains enough alkaline material (limestone for example) to neutralize any acid generated. Once acid drainage begins, it is difficult to control or stop. Because of this, extensive investiagions are conducted to predict and prevent the occurence of acid mine drainage for active and new mine operations.

Noranda Grey Eagle

Three months after the start of mining, in December of 1982, seepage of cyanide and cyanide-metal complexes began to occur from the base of the tailings dam and was discharged into Luther Gulch. The winter of 1982-83 was very wet and the rate of seepage from the dam not was anticipated from the initial hydrologic water balance models. Seepage through the core and foundation rock was not anticipated to begin until approximately four to five years after startup of operations. Investigations indicated that seepage was occurring through the core of dam, through fractures in the bedrock foundation of the dam, and through leaks in the grout curtain in the north half of the dam. During 1983 when investigations were occurring, the seepage flow from the toe of the dam ranged from 400 gpm during storm events to 75-80 gpm in August. The actual contaminated seepage from the tailings impoundment in August was 20-30 gpm; the difference is made up of natural seepage from springs or infiltration sources downstream of the dam core. Due to dilution from Luther Gulch, the levels of free cyanide in the stream were very low and it was concluded that there was no immediate threat to human health and safety, or adverse affect on aquatic life in Luther Gulch (Noranda, 1983).

Acid drainage from the old underground workings of the copper mine was compounding the problem, seeping into the tailings and mixing with the tailings seepage. It is not known when acid drainage first began to occur from the mine adits, but it most likely became a significant problem in the 1940's when the underground workings were extensively mined for copper. Documents dating from the 1950's and 1960's indicate that there was little aquatic life in Luther Gulch due to acid drainage. In 1969, there is a well-documented fish kill in Indian Creek which originated from the main mine adit of the Gray Eagle Copper mine (Coots, 1954 CDFG memo; Hanson 1969a, 1969b). The cause of the fish kill was determined to be from excavation within the mine adit which broke through a natural dam in the adit releasing a large volume of acid water and metal-laden sediment into Luther Gulch and Indian Creek.

Seepage from the toe of the dam was immediately controlled by installing a collection and pumpback system to return the seepage back into the tailings impoundment. After a year of investigations, the plan to control cyanide seepage from the tailings impoundment consisted of: sealing the old adits; and installing a waste water treatment plant below the toe of the dam. Treated seepage from the dam is piped down to a infiltration gallery (leach field) along Indian Creek north of Luther Gulch.

The pollution control system operated by Noranda Mining is currently regulated by orders from the California Regional Water Quality Control Board and must comply with waste discharge requirements set forth to protect beneficial uses of the waters of the Klamath Basin. Noranda has a 30-year corporate financial assurance commitment to treat the water to conform with water quality guidelines. Today, though the cyanide levels in seepage from the toe of the dam have diminished considerably from the levels in 1983, the high levels of dissolved metals in the seepage and free cyanide exceed water quality standards, and if untreated the metals would severely impact aquatic organisms in Luther Gulch. Though Noranda asserts that the current seepage from the dam has returned to the pre-Noranda conditions, a fully comprehensive demonstration of this has not been made. Furthermore, past and present sources of metals in the seepage has not been determined or differentiated. It is likely that in the future, various alternative treatment systems may be proposed by Noranda to treat the seepage from the tailings dam. Any treatment scheme, such as passive acid drainage treatment, needs to be fully evaluated, pilot tested and monitored over a significant period of time before it is implemented.

Old Gray Eagle Copper Mine Tailings/Mill Pond Site

An area known as the mill pond situated along Indian Creek below Luther Gulch is where all the tailings were deposited from the Gray Eagle Copper mine in the 1940's. Tailings up to about 20 feet in depth are deposited over approximately 15 acres of private land and 0.3 acres of land managed by the U.S. Forest Service. An acidic leachate stream drains from the tailings dump and mill pond and flows into Indian Creek. Downstream from the mill pond, the bedrock channel of Indian Creek is stained red from iron precipitates. The pollution problems from the mine tailings impair the aquatic habitat and water quality of Indian Creek.

During the operation of the Gray Eagle Copper Mine, process tailings from the mill facility up Luther Gulch were carried by a flume all the way down to the mill pond site on Indian Creek where they remain today. After mining operations ceased in 1945, the land was owned and used by various logging and lumber products companies. In 1954, Willamette Builders Supply Company ran plywood mill on the property and excavated the tailings out to make a log pond (U.S. EPA 1996).

Water quality concerns with the acidic leachate and erosion of the tailings have been noted since the early 1950's. A California Fish and Game live fish trap study conducted in November of 1952 indicated that the leachate stream was toxic to fish. Most of the fish died that were placed in a trap in Indian Creek just below the mine tailings dump. In the trap placed one mile below the mine tailings dump, all the fish survived (Coots, 1952). In 1981, California Department of Fish and Game collected water and sediment samples from the leachate stream adjacent to the old mill pond and from Indian Creek (Wilson, 1981). The leachate stream was acidic, having a pH ranging from 3.2 to 4.5. Metals analyzed included total and dissolved iron, copper, zinc and cadmium. Total and dissolved copper and zinc levels in the leachate stream samples greatly exceeded concentrations that are toxic to freshwater fish. Water from Indian Creek diluted the pollutant discharge to concentrations well below toxic levels. They concluded that dissolved iron from the leachate stream and ferric iron hydroxide precipitates were the principal problems of concern to aquatic life in Indian Creek. They recommended further sampling and testing at different times of the year.

In 1996, a team from the U.S. Environmental Protection Agency (EPA) conducted a preliminary site assessment of the tailings dump and water quality of the leachate stream, Luther Gulch and Indian Creek above and below the site (Guevarra, 1996a; 1996b). The study was in response to concerns brought forth to the EPA by the Karuk Indian Tribe. Their findings were: (1) the mill pond tailings had high concentrations of arsenic, iron, copper and zinc; (2) iron precipitates out as a hardened coating on rocks and stream gravels where the leachate stream contacts or flows into Indian Creek water; (3) the leachate stream exceeds aquatic life criteria for copper, iron, nickel, and zinc; (4) a bioassay study indicated that the leachate stream is lethal to trout fingerlings and possibly most aquatic wildlife. Indian Creek water below the mill pond site had elevated levels of iron, copper and zinc as compared to samples taken upstream of the mill pond. Water sampled just downstream from the confluence of the leachate stream and Indian Creek exceeded the EPA criteria for iron. This study is a preliminary assessment which was conducted at a period of high flow. No flow measurements of the leachate stream or metal loading estimates were made. Risk evaluations of threats to human health or the environment were not conducted.

The California Regional Water Quality Board, North Coast Region, and the U.S. EPA are the and lead regulatory agencies handling the evaluation and response actions at this site. Since the site is mostly on private land, the U.S. Forest Service is not a lead agency, but has been involved as a cooperating agency. The current discharge of the leachate stream into Indian Creek is unauthorized and does not comply with the Klamath River Basin Plan, among other policies and regulations. The likely future actions at the site would be the issuance of clean up orders by the California Regional Water Quality Control Board to all prior owners of the site. No time line for this action has been developed.